



Integrating and Visualizing Tropical Cyclone Data Using the Real Time Mission Monitor

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Abstract

The Real Time Mission Monitor (RTMM) is a visualization and information system that fuses multiple Earth science data sources, to enable real time decision-making for airborne and ground validation experiments. Developed at the NASA Marshall Space Flight Center, RTMM is a situational awareness, decision-support system that integrates satellite imagery, radar, surface and airborne instrument data sets, model output parameters, lightning location observations, aircraft navigation data, soundings, and other applicable Earth science data sets. The integration and delivery of this information is made possible using data acquisition systems, network communication links, network server resources, and visualizations through the Google Earth virtual globe application.

RTMM is extremely valuable for optimizing individual Earth science airborne field experiments. Flight planners, scientists, and managers appreciate the contributions that RTMM makes to their flight projects. A broad spectrum of interdisciplinary scientists used RTMM during field campaigns including the hurricane-focused 2006 NASA African Monsoon Multidisciplinary Analyses (NAMMA), 2007 NOAA-NASA Aerosonde Hurricane Noel flight, 2007 Tropical Composition, Cloud, and Climate Coupling (TC4), plus a soil moisture (SMAP-VEX) and two arctic research experiments (ARCTAS) in 2008.

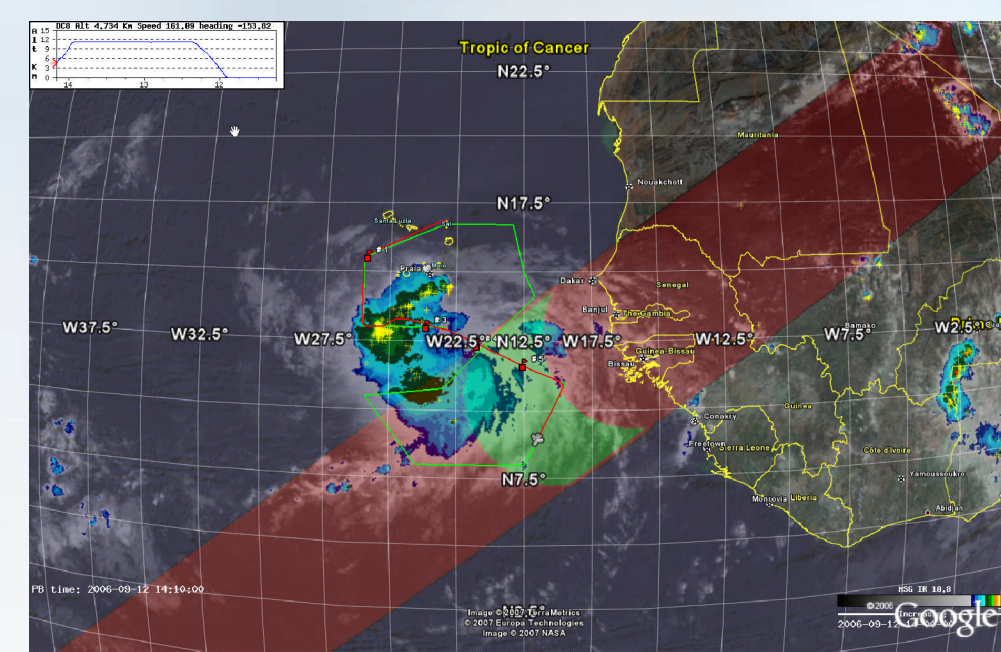
Improving and evolving RTMM is a continuous process. RTMM recently integrated the Waypoint Planning Tool, a Java-based application that enables aircraft mission scientists to easily develop a pre-mission flight plan through an interactive point-and-click interface. Individual flight legs are automatically calculated "on the fly". The resultant flight plan is then immediately posted to the Google Earth-based RTMM for interested scientists to view the planned flight track and subsequently compare it to the actual real time flight progress.

We are planning additional capabilities to RTMM including collaborations with the Jet Propulsion Laboratory in the joint development of a Tropical Cyclone Integrated Data Exchange and Analysis System (TC IDEAS) which will serve as a web portal for access to tropical cyclone data, visualizations and model output.



"Making Science Easier"

The Real Time Mission Monitor (RTMM) is an interactive visualization application that provides situational awareness and field asset management to enable adaptive and strategic decision making during airborne field experiments.



- Integrates satellite, airborne, and surface data sets
- Tracks airborne vehicle state information
- Displays model and forecast parameters



Dave Starr, Lead Mission Scientist uses RTMM from the TC4 Operations Center

RTMM is available to:

- Scientists
- Program Managers
- Educators and Students
- Media and Public Affairs



RTMM enables

- Real time interactions & collaborations
- Post-flight mission review and case study development

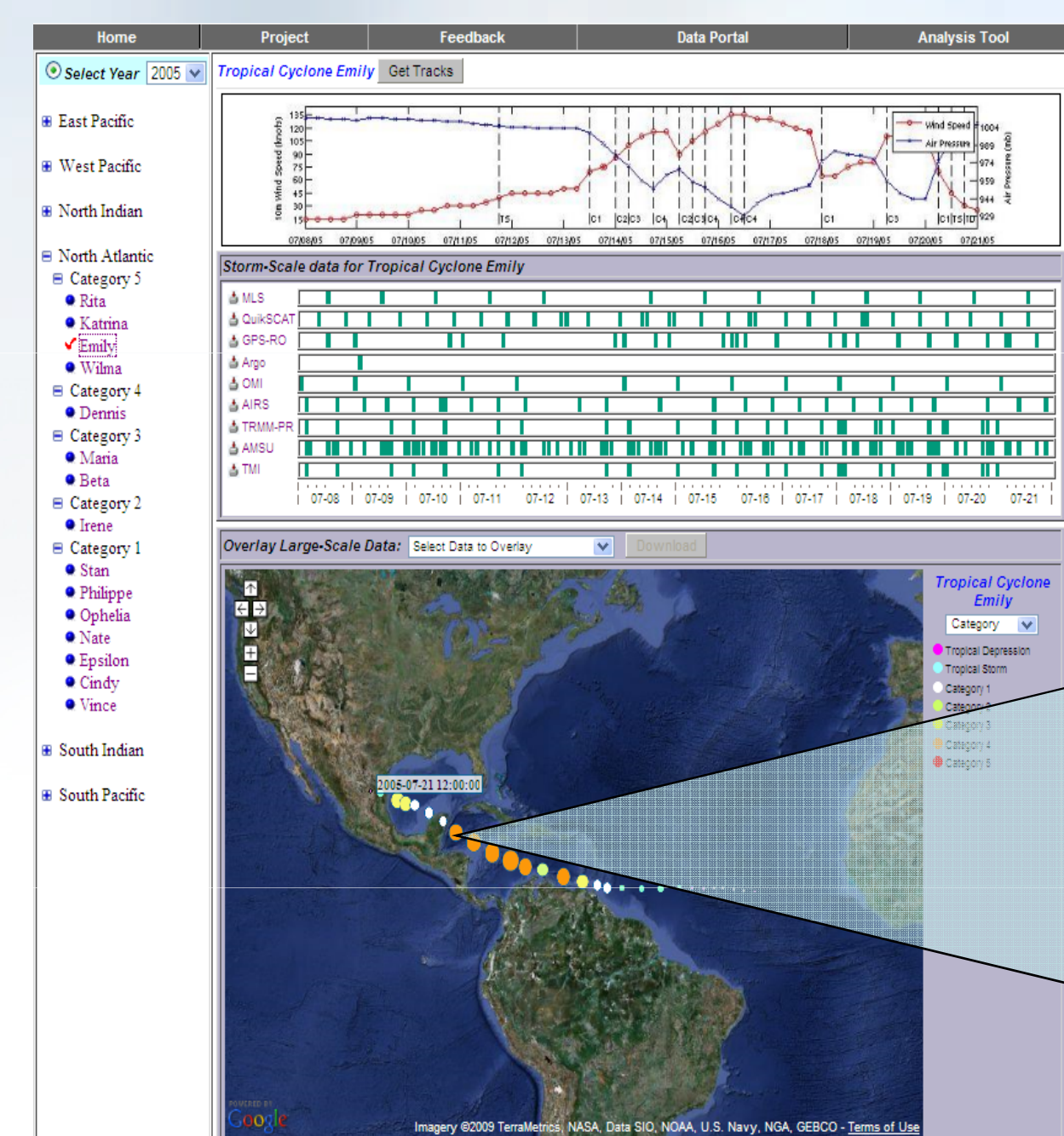
Paraphrasing the BASF television commercial:
"We don't make the science, we make the science easier"



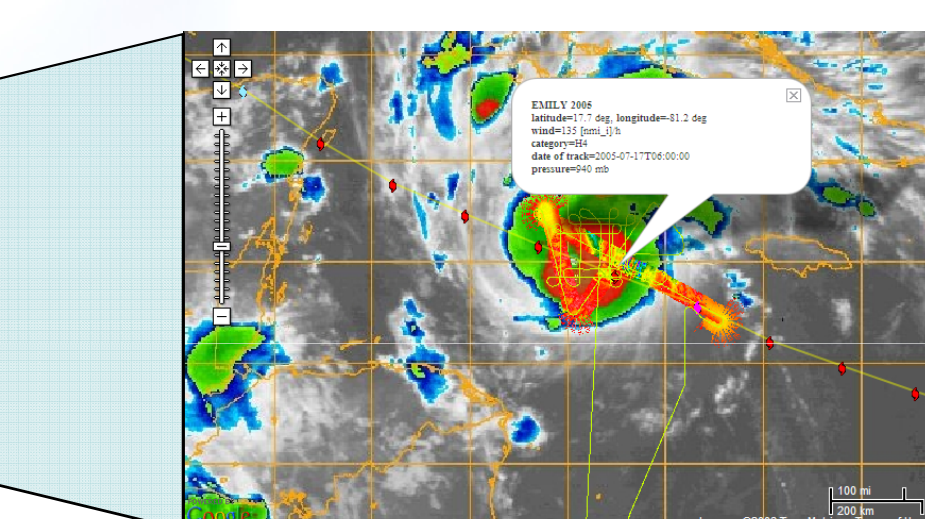
Tropical Cyclone – Integrated Data Exchange and Analysis System

Joint NASA Jet Propulsion Lab and Marshall Space Flight Center Project

Objective: To provide fusion of multi-parameter hurricane observations (satellite, airborne and *in-situ*) and model simulations with the purpose of:



- supporting both research and field campaigns (incorporating RTMM)
- understanding the physical processes
- improving hurricane forecast by facilitating model validation and data assimilation
- enabling the development of new algorithms, sensors and missions.



ER2/AMPR passive microwave over flight of H. Emily during the 2005 TCSP field experiment

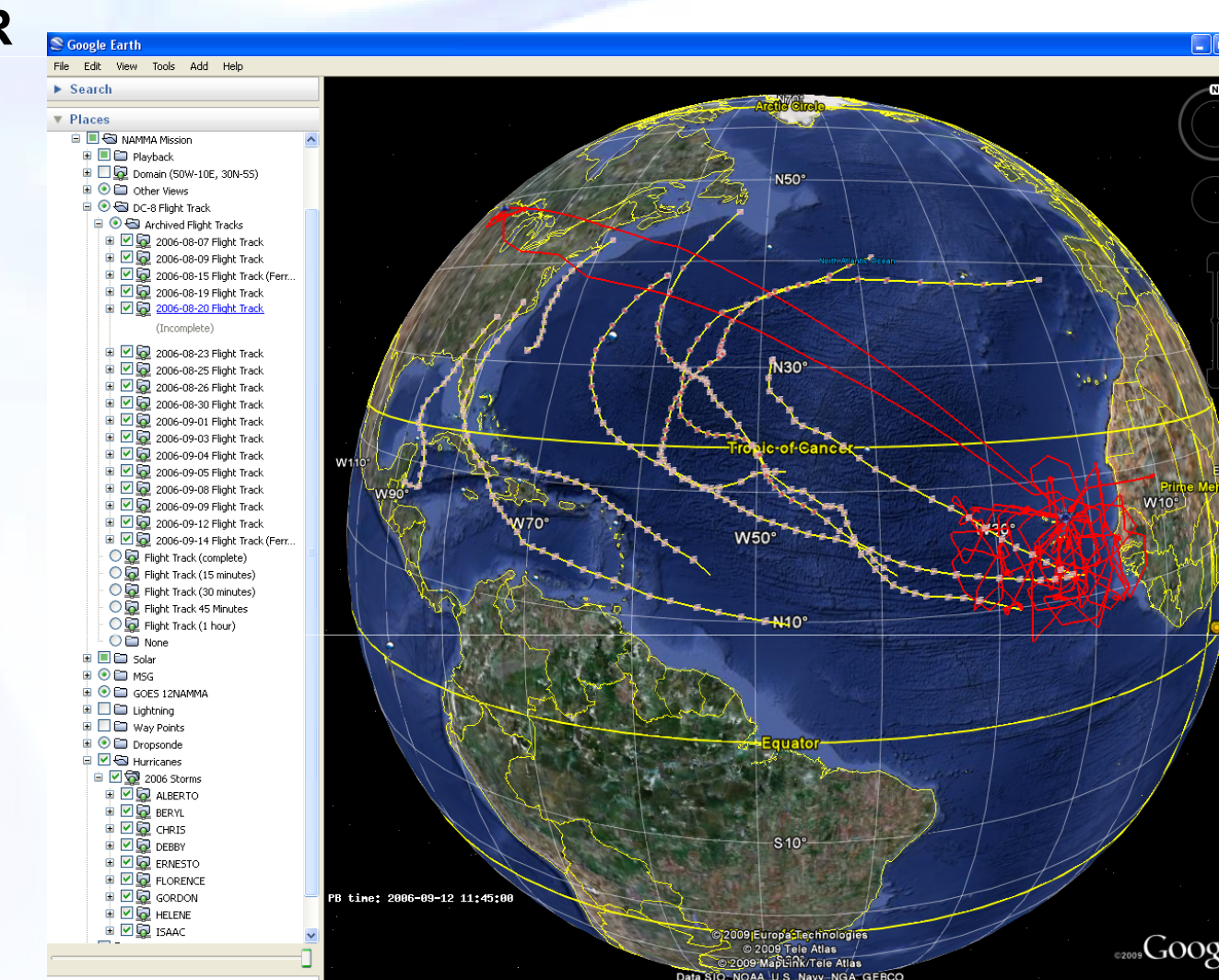
Integrate NASA Airborne field data sets with satellite data



Hurricane Campaign Data Sets

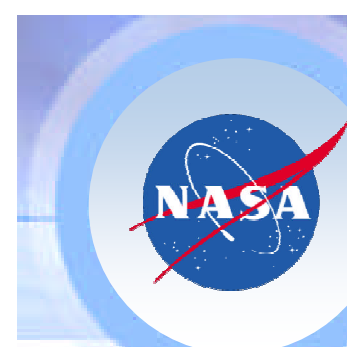
1998 CAMEX-3, 2001 CAMEX-4, 2005 TCSP, 2006 NAMMA

- Advanced Microwave Precipitation Radiometer AMPR
- Aerosonde
- Surface Lightning Networks (ATD and Zeus)
- Atmospheric Emitted Radiance Interferometer AERI
- CO By Attenuation Laser Transmission COBALT
- Cloud and Aerosol Particle Characterization CAPAC
- Cloud Microphysics CAPS-PIP
- Cloud Radar System CRS
- Cloud Water Content CVI
- Dropsonde and Radiosonde networks
- ER-2 Doppler Radar EDOP
- High Altitude MMIC Sounding Radiometer
- Langley Aerosol Research Group Experiment
- Laser Hygrometers
- Lidar Atmospheric Sensing Experiment LASE
- Lightning Instrument Package LIP
- Meteorological Measurement System MMS
- Microwave Temperature Profiler MTP
- Mobile Integrated Profiling System MIPS
- MODIS Airborne Simulator MAS
- Multispectral Atmospheric Mapping Sensor MAMS
- NOAA Lyman-Alpha Hygrometer
- Polarimetric Scanning Radiometer
- 2nd Gen. Airborne Precipitation Radar APR-2
- Scanning Raman Lidar
- Senegal Rain Gage, Radiosonde, and Tower Flux sites
- SMART-COMMIT Mobile Labs
- TOGA Radar

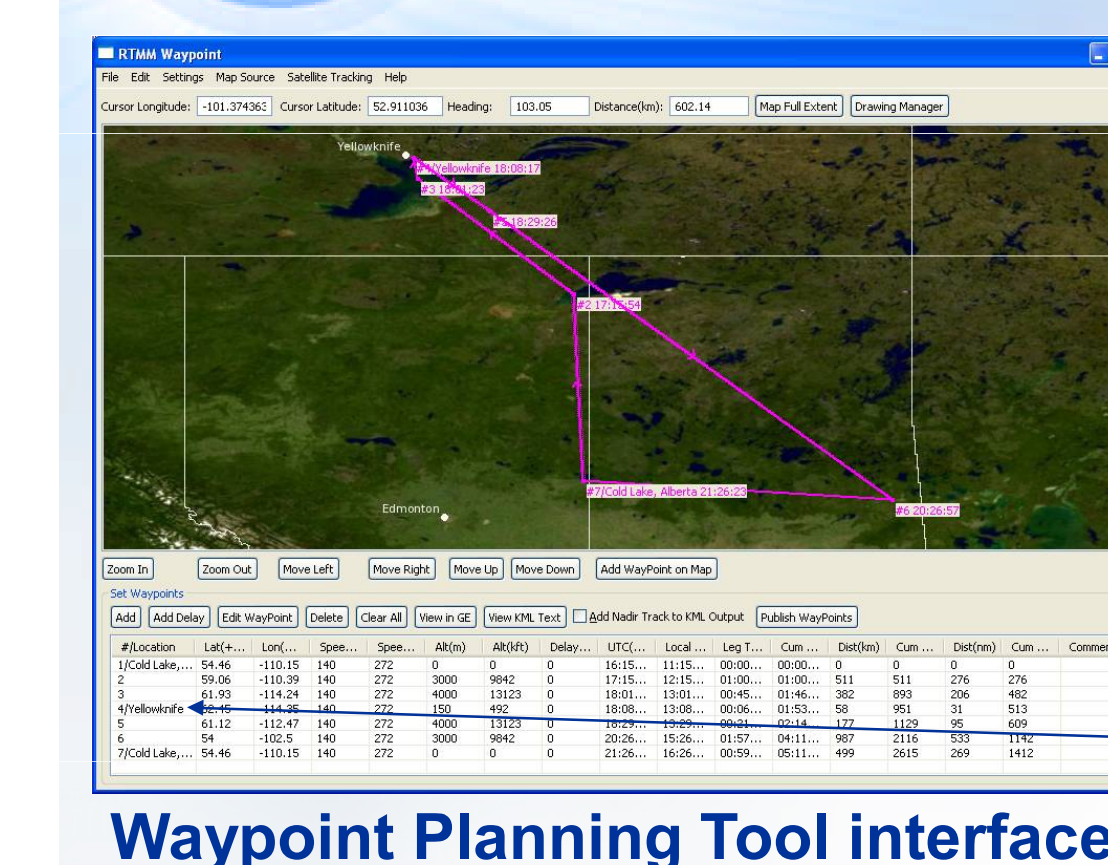


NAMMA flight tracks & 2006 Hurricane Tracks

Incorporate historical archived tropical cyclone database into RTMM



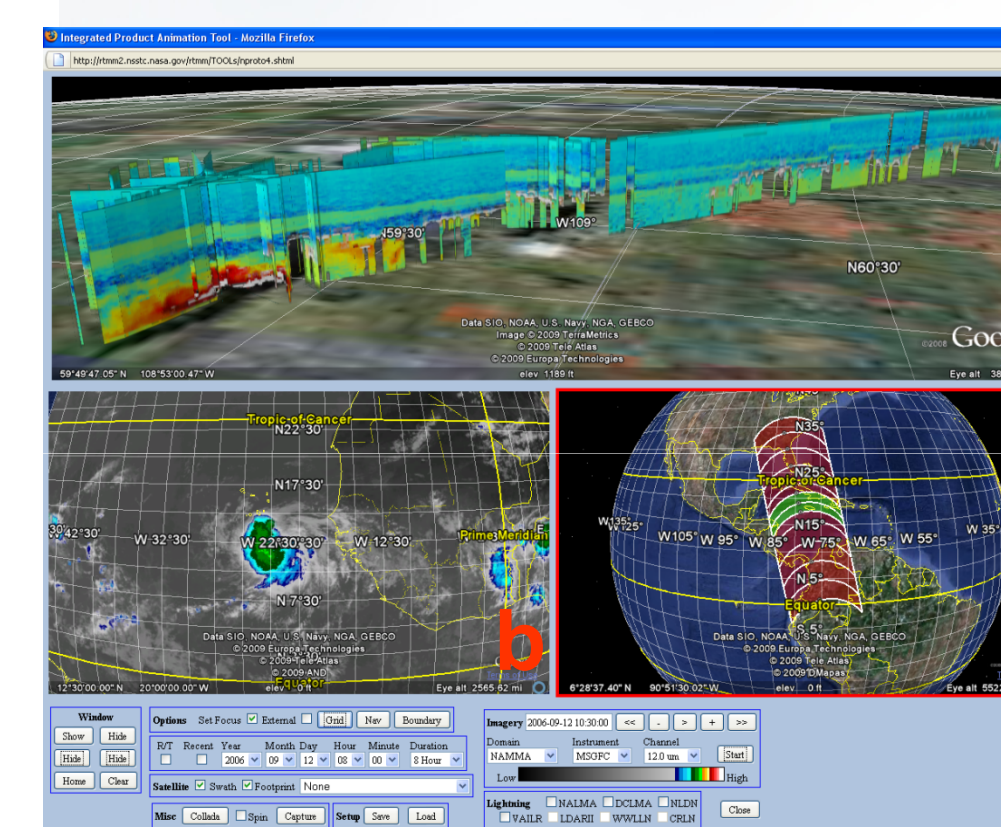
New Tools and Directions



Waypoint Planning Tool interface

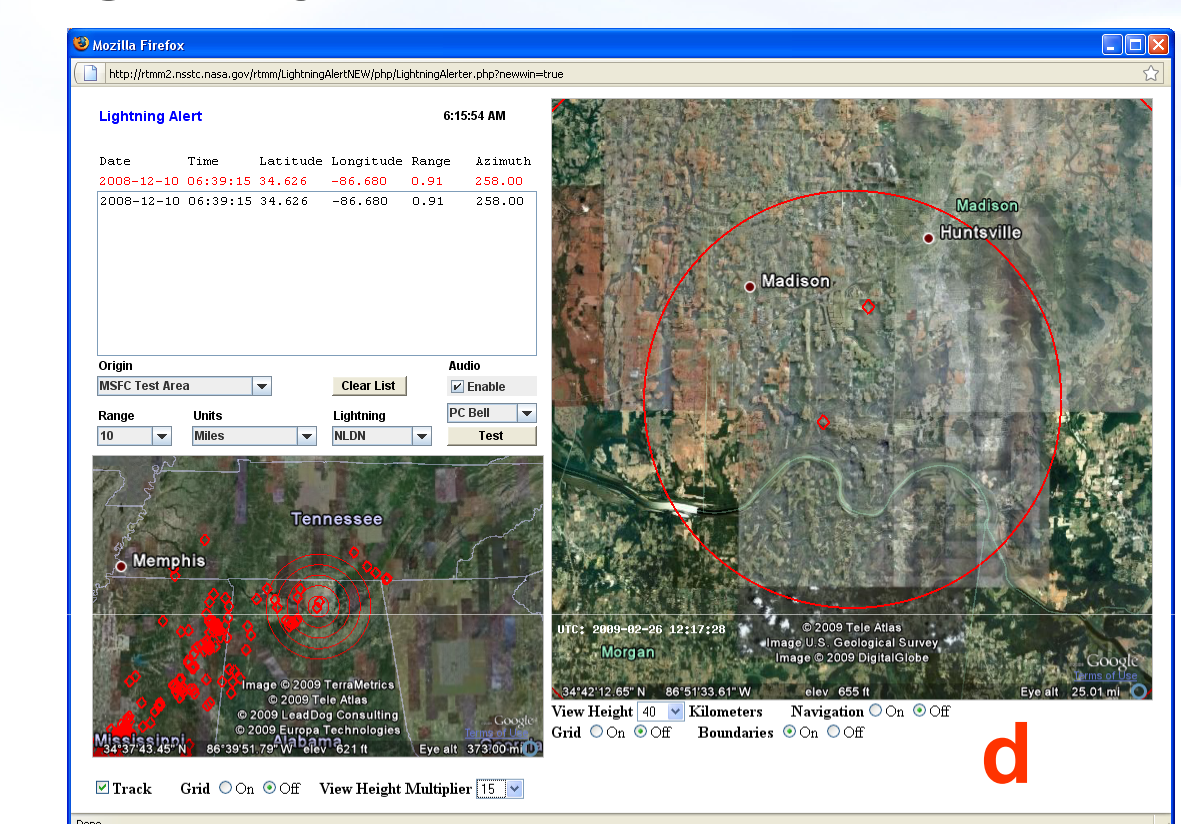
Waypoint Planning Tool

- Standalone interactive point-and-click enables quick creation of flight plans
- Generates and reads KML files for insertion into RTMM
- Multiple aircraft, satellites, and instrument field of view
- Individual flight legs fully described and visualized



New web browser plug-in application provides greater flexibility and expands the capability to open multiple RTMM windows.

- Lidar curtain plot
- Real time animated hurricane imagery
- Satellite tracking – real time and predictive
- Lightning alert – real time and historical



In Cooperation With:

- Larry Freuding – NASA Dryden Global Test Range
- NASA Ames Earth Science Project Office (ESPO)
- Svetla Hristova-Veleva – Jet Propulsion Laboratory
- The many airborne and instrument scientists from CAMEX, TCSP, NAMMA, TC4, Aerosonde Demonstration, ARCTAS & SMAP-VEX field campaigns

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- Andrew Roberts – Airborne Science Program Manager
- George Komar – Earth Science Technology Office Manager

More Information:

To view animations and replays of individual flights, please go to the RTMM web site at:

➢ <http://rtmm.nsstc.nasa.gov>

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